
भूकृत्रिम — पोली आलीफीन ज्योमैम्बरेन
की प्रतिबल दरार प्रतिरोध नोचड स्थिर
तन्यता लोड परीक्षण के मूल्यांकन के
के लिए टेस्ट की विधि

**Geosynthetics — Method of Test for
Evaluation of Stress Crack
Resistance of Polyolefin
Geomembranes Using Notched
Constant Tensile Load Test**

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FOREWORD

This Indian Standard was adopted by the Bureau of Indian Standards, after the draft finalized by the Geosynthetics Sectional Committee had been approved by the Textile Division Council.

In the preparation of this standard assistance has been drawn from ASTM D5397 – 07 ‘Standard test method for evaluation of stress crack resistance of polyolefin geomembranes using notched constant tensile load test’, issued by the American Society for Testing and Materials, USA.

The composition of the Committee responsible for the formulation of this standard is given in Annex B.

For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance with IS 2 : 1960 ‘Rules for rounding off numerical values (*revised*)’. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

Indian Standard

GEOSYNTHETICS — METHOD OF TEST FOR EVALUATION OF STRESS CRACK RESISTANCE OF POLYOLEFIN GEOMEMBRANES USING NOTCHED CONSTANT TENSILE LOAD TEST

1 SCOPE

1.1 This test method is used to evaluate the susceptibility of polyolefin geo-membrane sheet material to stress cracking under a constant tensile load condition in an accelerated environmental condition.

1.2 This test method measures the failure time associated with a given test specimen at a specified tensile load level. Results from a series of such tests utilizing a range of load levels can be used to construct a stress-time plot on a log-log axis.

2 REFERENCES

The following standards and special publication are necessary adjuncts to this standard:

<i>IS No.</i>	<i>Title</i>
13321 (Part 1) : 1992	Glossary of terms for geosynthetics: Part 1 Terms used in materials and properties
13360 (Part 5/Sec 1) : 1996	Plastics — Methods of testing: Part 5 Mechanical properties, Section 1 Determination of tensile properties — General principles
13360 (Part 5/ Sec 2) : 1996	Plastics — Methods of testing: Part 5 Mechanical properties, Section 2 Determination of tensile properties — Test conditions for moulding and extrusion plastics
13360 (Part 5/ Sec 3) : 1999	Plastics — Methods of testing: Part 5 Mechanical properties, Section 3 Determination of tensile properties — Test conditions for films and sheets
SP 45 : 2014	Handbook on glossary of textile terms

3 TERMINOLOGY

For the purpose of this standard the following definitions and those given in SP 45 and IS 13321 (Part 1) shall apply.

3.1 Geomembrane — A very low permeability synthetic membrane liners or barriers used with any geotechnical engineering related material so as to

control fluid migration in a man-made project, structure, or system.

3.2 Stress Crack — An external or internal crack in a geomembrane caused by tensile stresses less than its short-time mechanical strength.

4 PRINCIPLE

A dumbbell shaped notched test specimen of geomembrane is subjected to a constant tensile load in the presence of a surface-active agent and at an elevated temperature. The time to failure of the test specimen is recorded. The results of a series of such tests conducted at different stress levels are presented by plotting stress level against failure time for each stress level on a log-log axis.

5 APPARATUS

5.1 Blanking Die — A die suitable for cutting test specimens to the dimensions and tolerances shown in Fig. 1. The tolerance on all the dimensions shown in Fig. 1 shall be ± 0.02 mm.

5.2 Notching Device — A device or machine that can produce a consistent notch depth.

5.3 Blade — A single-edged razor made of carbon steel. The tip profile is that of an arrow rather than that of a chisel point. The sharpness of the point is critical to the cleanliness of the cut which effects the results of the test significantly.

5.4 Stress Cracking Apparatus — Equipment suitable for subjecting test specimens to a tensile stress of up to 13.8 MPa. The specimens shall be maintained at a constant temperature of $50 \pm 1^\circ\text{C}$ while being totally immersed in a surface-active agent. The solution shall be constantly agitated to provide a uniform concentration throughout the bath.

NOTE — The typical apparatus is shown in Fig. 2. This apparatus is capable of testing 20 specimens at a time. This equipment uses a lever system with a mechanical advantage (MA) of three to impose the desired loading on each specimen. The surface active agent in which the specimens are immersed is contained in an open stainless steel tank. A submersion heater and controller are used to maintain the test temperature. A pump keeps the liquid in a constant state of agitation. A timing clock

for each test specimen is also provided to record automatically the failure time of the test specimens to the nearest 0.1 h.

6 REAGENT

The reagent shall consist of 10 percent surface-active agent with 90 percent water. The surface-active agent is *Igepal CO-630* that is nonylphenoxy poly (ethyleneoxy) ethanol. The reagent shall be stored in a closed container. The reagent in the bath shall be replaced every two weeks to maintain a constant concentration.

7 TEST SPECIMENS

As a laboratory sample for acceptance testing, take a full width swatch approximately 1 m long in the machine direction from a roll. The sample may be taken from the end portion of a roll provided there is no evidence it is distorted or different from other portions of the roll. At least thirty test specimens are cut from

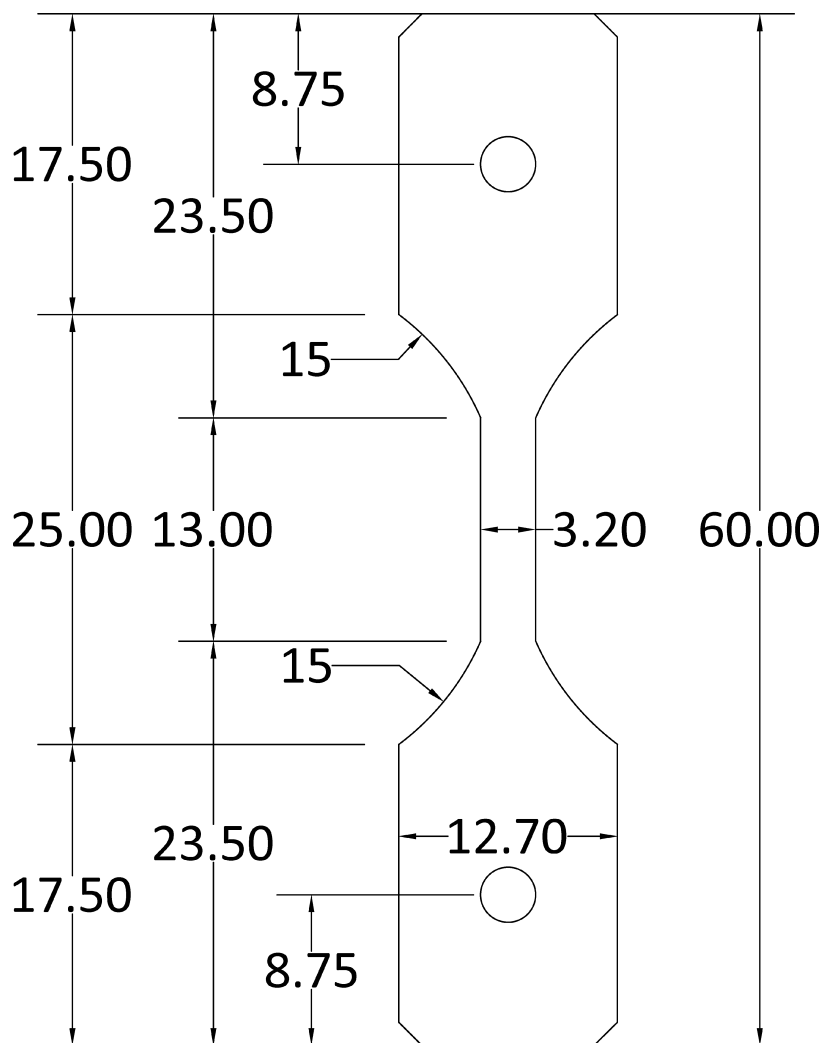
each swatch in the laboratory sample. For each set of tests, all specimens shall be taken from one direction only.

8 PROCEDURE

8.1 Measure the thickness of each individual test specimen at its minimum cross-section to the nearest 0.013 mm. The variation in thickness shall not be greater than ± 0.026 mm of the nominal thickness of the geomembrane.

8.2 Cut into each specimen a control imperfection (notch) on one surface as shown in Fig. 3. The depth of the notch shall produce a ligament thickness of 80 percent of the nominal thickness of the specimen.

8.3 Inspect the edge of the blade for scratches and burrs under normal vision prior to the cut. No single blade shall be used for notching more than 20 test specimens.



All Dimensions in millimetres to an accuracy of 0.02 mm

FIG.1 DIMENSIONS OF TEST SPECIMEN

8.4 Test specimens are loaded at various percentages of their room temperature yield stress. The applied stress levels shall range from approximately 20 to 65 percent at maximum increments of 5 percent. Three specimens are tested at each stress level to produce statistically significant results.

NOTE — To develop the entire curve in a single direction at the recommended values listed above shall require ten increments at three specimens each or 30 individual tests. If both directions are to be checked, the entire test shall require twice as many test specimens.

8.5 For each set of test, the yield stress of the material shall be measured according to applicable method as specified in IS 13360 (Part 5/Sec 1), IS 13360 (Part 5/Sec 2), IS 13360 (Part 5/Sec 3). Five specimens shall be tested and the average value is used to calculate the applied force. The test specimens shall be cut from the same sample and same direction.

8.6 Calculate the tensile force to be applied to each individual specimen by the following formula:

$$\text{Applied force} = \frac{A \times \sigma_y \times w \times t_L}{MA}$$

where

Applied force = force to be applied to achieve a specific percentage of the yield stress;

A = percentage of yield stress to be achieved;

σ_y = the yield stress of the material at room temperature;

w = width of the neck of the test specimen;

t_L = the ligament thickness of the test specimen, that is, recommended to be 80 percent of the nominal thickness; and

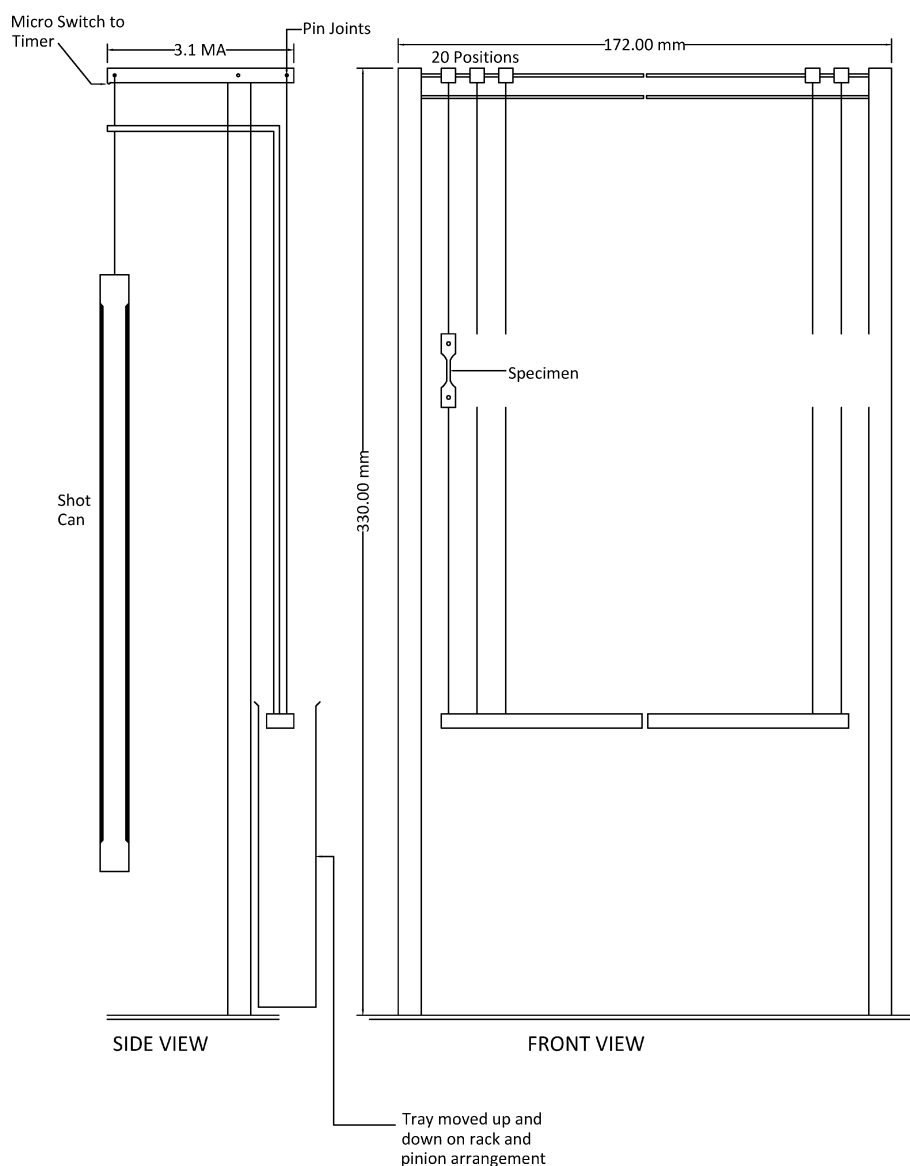


FIG. 2 CONSTANT STRESS LOADING APPARATUS CONSISTING OF TWENTY SPECIMEN TEST POSITION

MA = mechanical advantage of the test apparatus, that is 3.0 for the apparatus shown in Fig. 2.

8.7 Fill the test bath with reagent and adjust the temperature to $50 \pm 1^\circ\text{C}$.

8.8 Attach the test specimens to the hooks of the test apparatus.

8.9 Adjust the distance between the lever arm and the switch to a dimension equal to 20 mm.

8.10 Immerse the test specimens and allow temperature equilibrium to be reached. The minimum time is 30 min.

8.11 Prepare the appropriated weight of lead shot (or other types) required for each individual test specimen according to the calculation in **8.6**.

8.12 Load each individual specimen with its respective weight and record the elapsed time to failure to the nearest 0.1h.

8.13 For each of the applied stress levels, calculate the arithmetic mean of the three failure time values and

report it as the 'average failure time' for that particular applied stress level.

9 INTERPRETATION OF RESULTS

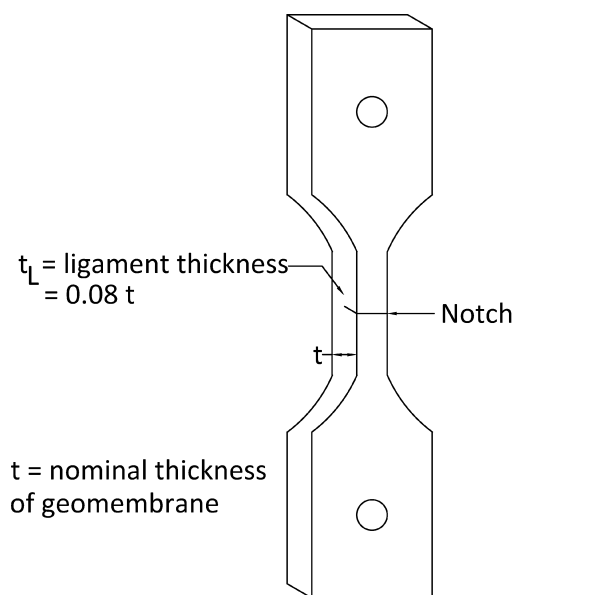
Present the test data in graphic form by plotting the logarithm of percentage yield stress *versus* the logarithm of the average failure time for each stress level.

NOTE — Procedure to perform a single point notched constant load test has been specified in Annex A.

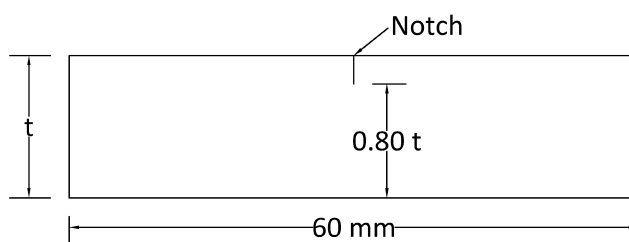
10 REPORT

10.1 Report the following:

- Complete identification of the material tested,
- Yield stress used in the test method,
- Report the average failure time and coefficient of variation values for each of the applied stress levels, and
- A plot of the percent yield stress against average failure time on log-log axis.



Front view of the cut test specimen



Side View of the Test Specimen

FIG. 3 FRONT AND SIDE VIEWS OF THE NOTCHED TEST SPECIMEN OF NCTL TEST

ANNEX A

(Clause 9)

PROCEDURE TO PERFORM A SINGLE POINT NOTCHED CONSTANT LOAD TEST

A-1 TEST SPECIMENS

Five test specimens are cut from a representative sample of geomembrane sheet under investigation. All the specimens shall be cut in the same direction.

NOTE — This procedure is not appropriate for testing geomembrane with textured or irregular rough surfaces. The irregular surface makes the determination of the ligament thickness and subsequent applied stress unreliable.

A-2 PROCEDURE

A-2.1 The specimen notching shall be carried out as per 8.1 to 8.3.

A-2.2 All notched test specimens shall be loaded to an equal stress level.

A-2.2.1 The stress level applied to the test specimens shall be either:

- a) Thirty percent of the room temperature yield stress of the sheet under investigation. The yield stress of the sheet shall be measured as per the applicable method specified in IS 13360 (Part 5/Sec 1), IS 13360 (Part 5/Sec 2), IS 13360 (Part 5/Sec 3). Five specimens shall be tested and the average value is used to calculate the applied force. The tensile test specimen shall be cut from the same sample and same direction as specified in A-1.
- b) Other stress or force values as mutually agreed to by the parties involved.

A-2.3 Calculate the applied force from the following formula:

$$F = \frac{\sigma \times w \times t_L}{MA}$$

where

F = force to be applied to achieve 30 percent of the yield stress;

σ = the applied stress value determined either A-2.2.1 (a) or (b);

w = width of the neck of the test specimen;

t_L = the ligament thickness of the test specimen, that is, recommended to be 80 percent of the nominal thickness; and

MA = mechanical advantage of the test apparatus.

A-2.4 The incubation condition for the notched test specimens shall be in accordance with 8.7 to 8.12.

A-2.5 The duration of the test shall be either one of the following:

- a) The tests are terminated immediately after a predetermined length of time which is mutually agreed upon by the parties involved.
- b) The tests continue until all the five specimens fail. The arithmetic mean of the five failure times is calculated along with the coefficient of variation.

A-3 REPORT

A-3.1 Complete identification of the sheet material tested including test orientation.

A-3.2 Room temperature yield stress and percent of yield stress or other stress/load used in the test.

A-3.3 Report any changes that are different from the standard herein.

A-3.4 If the tests are run for a predetermined time period, state the following:

- a) The prescribed time period as set by the parties involved.
- b) If specimen(s) fail before the prescribed time period, report their failure time (s), otherwise state 'no failure'.

A-3.5 If the tests continue until failure, report the average time and coefficient of variation.

ANNEX A

(Foreword)

COMMITTEE COMPOSITION

Geosynthetics Sectional Committee, TX 30

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Member Secretary
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